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TEACHING AND LEARNING CALCULUS USING TI-NSPIRE

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Abstract

Failure to understand abstract concept among students might lead to misconception in understanding Calculus. Using instructional activities in discovering mathematical concepts by integrating technology may be one learning style to suit their needs. This study explored the concept of Calculus by using TI-Nspire. It was conducted by using a case study research design. The participants of this study were three Form Five students from a mixed ability classroom of a public school in Selangor. Instructional activities were designed on teaching and learning of the component Calculus in SPM Additional Mathematics. Two selected students will be interviewed based on their responses from the post-test. In addition, this study will provide a better understanding in improving students' skills in learning Calculus.

Keywords: Calculus, TI-Nspire, Abstract concept in Calculus

Introduction

The thought of calculus no longer involve computations which performed by simple arithmetic. Calculus concepts becoming more abstract and complicated for students and the teaching and learning of it can be tough (Gordon, 2004). The teaching approaches in calculus have become basically list of procedures to follow. Students are just practising usual routine in algebraic manipulations.

In teaching Calculus, teachers focus more on procedures rather than to understand the concepts (Zachariades *et al*, 2007). According to Axtell (2006), the researcher thinks that teaching calculus using traditional approach fails to understand students the basic concept of calculus. Gordon (2004) suggested that students must choose the right tools for example graphing calculators to assist in learning calculus and apply the balance approach to solve calculus problems.

Technology can help to develop understanding of abstract mathematical concepts through visualisation and graphic representation. This will increase the students' competence to obtain better knowledge on mathematics. Bert Waits, co-founder of T3 (Teachers Teaching with Technology) states that graphing calculator is a great pedagogical tool as it offers multi-representational approaches in teaching and learning of Mathematics.

Literature Review

Graphics calculators are hand-held, battery operated devices that are equipped with functions to plot graphs, give numerical solutions to equations, and perform statistical calculations, operation on matrices and to perform more advanced mathematical functions such as algebra, geometry and advanced statistics (Kor & Lim, 2004). Based on researches supporting the potential of graphing calculators, it is recommended for it to be implement in mathematics education to enhance students' experience with multiple representations of mathematical ideas (NCTM, 1989). The graphics calculator is a highly effective tool because it encourages learners in solving mathematical problems by making mathematics interesting (Noraini, 2010).

Zachariades *et al*. (2007) points out that graphing calculator which offers dynamically connected visual, numerical and representational features is an applicable tool in teaching calculus. The usage of graphing calculator which offer better linkage between algebraic representation and graphical representation in calculus supported by Tiwari (2007) in which shows positive outcome when it is used as an additional tool in enhancing students' understanding in learning differential calculus.

Alkhateeb and Wampler (2002) performed a research on the impact of graphing calculators on learning derivatives. Students who use graphing calculator show greater achievement than those who did not. Furthermore, Crocker (1991) discovered that usage of graphing calculator among students can stimulate students to try different strategies in solving calculus problem. Harvey, Waits and Demana (1995) also viewed that there are improvement in students' response to calculus questions using graphing calculator. Jones (2005) expressed that by using graphing calculators, it allow students to solve problems graphically, numerically and algebraically.

Research Purpose

The purpose of this study was to investigate how students and teacher attempt to use TI-Nspire handheld technology in teaching and learning calculus. Specifically, this study aimed to answer the following research questions:

1. What experiences do students and researcher express of the learning environment with TI-Nspire handheld technology?
2. How has TI-Nspire technology affect the teaching practice of a teacher?
3. How does the use of TI-Nspire technology affect student's motivation, interest and self-confidence when working with mathematical instructional activities?

Methodology

Design

This study employed a case study design in order to give view of students' and teacher's experience of the learning setting with TI-Nspire software on the laptop version for teacher and handheld version for students. Thus, this study mainly focus on qualitative approaches to provide answers to the research questions. The researcher plays the role as the teacher during this study. The teaching and learning process occurred within a small tutoring group.

Materials and Instruments

The materials used involved the following main parts:

a.) Six instructional activities were designed to achieve the learning objectives in Calculus based on the Additional Mathematics Curriculum Specification:

b.) One student were chosen to be interviewed in semi-structured form directly after the teaching of the sixth instructional activities.

c.) All students had to answer a set of questionnaire to express their experience of the learning environment by using TI-Nspire.

d.) TI-Nspire exercises based on the problem-solving task were designed to detect students' ability to perform and apply the technology in a versatile way.

Study Development

This section describes on the study development which includes the activities performed and their objectives. The case study was performed during six meetings (thrice a week). There were three Form Five students attended all of the meeting. They were briefed on the purpose of the study at the beginning and researchers stressed on their commitment during the study.

This study took place over the course of two weeks. Initially, students were trained to some command and features in the TI-Nspire to make them familiarise with the handheld technology. The training session was to introduce the interface design and use the algebraic, graphical and numerical functions of the TI-Nspire. The first weeks involved a lesson on the concepts of limit, differentiation and integration. Lessons were delivered through PowerPoint presentations and involved note, directed examples and 'drill and practice'. Graphing calculators were allowed throughout the lesson but researcher never stressed on it during the first week.

During the second week, to observe the use of graphing technology, researcher taught similar lesson but stressed more on the use of TI-Nspire. Each instructional activities were designed for 40 minutes lesson. Two hour meetings were conducted to complete two instructional activities. At the end of every lesson, students work on the exercises related to the concept learnt by using TI-Nspire technology. Responses recorded in the activity sheet and *tns*-file containing the answers were collected and analyzed. Students completed a questionnaire relative to the activities solved by using the handheld technology, as an attempt to collect data on their opinions on the quality of the teaching and how it has affected their motivation, interest and self-confidence. Along the study, students' attitude toward the lesson were observed and recorded. An interview was performed with one student aiming to obtain further information on her experience of the task and of TI-Nspire in general. The interview were made and recorded, and also later transcribed.

Results and Discussion

Students' and researcher experience of a learning environment with TI-Nspire

The combined data from the interviews and the questionnaires give an interesting picture of the advantages and the disadvantages with using TI-Nspire technology. Below are well-known opinions of students and researcher in learning using the hand-held technology.

a.) Colourful and clear screen.

b.) Fast and flexible to work with.
c.) Easier to present new concepts and demonstrate in the class.
d.) Manage more difficult tasks, on a higher level.
e.) Learn more and understand mathematics better.

The interview gave many interesting points of view from the students. Example from the interview:
S: It's very smooth and interesting gadget in mathematics. It's like a mini computer and I can even save my documents in it. So, instead of boring exercise book, actually I can use it as my note book and exercise book.

Below is the researcher's point of view on teaching and learning mathematics by using TI-Nspire technology.
'I am very positive in using every kind of technology software and tools in my class. Based on using this new teachnology, it can give more understanding on learning mathematics but every tool and software must be accompany by an efficient learning activities or instructional module. It can give much better picture of mathematics concept. It is fun and interesting with the colourful and distinct screen. It help my students to explore and learn the concept by themselves. Besides, as a teacher myself, I feel motivated when my students get some wow-experiences in knowing the beautiful of mathematics.'

Generally, difficulties in using TI-Nspire technology were viewed by students and the researcher too. Common difficulties by students and researchers are collected.
a.) Hard to start with TI-Nspire.
b.) Takes time to learn how to use TI-Nspire.
c.) Difficult to apply different settings on the calculator. (Example: using Graph Trace function in the calculator)
d.) Sometimes difficult to know how to start solving a problem by using graphing calculator (Students need proper strategy in solving a problem by applying the graphing calculator)
e.) It is essential that you also practice solving tasks with paper and pencil. You must do both.

The interview gave many interesting points of view from the students. Example from the interview:
S: The calculator was little difficult to learn at the beginning. Maybe, I need one month to two months to get use to the technology itself before applying it in the class.
From the interview, student explained how complicated TI-Nspire was, the first time she started using it. But she answered that after a short while, when she were familiar with the handhelds, it did not seem so complicated at all. The students' versatility in using TI-Nspire progressed substantially during the study, and by the end of it many of the difficulties begin to disappear.
Below is the researcher's point of view on the difficulties in teaching and learning mathematics by using TI-Nspire technology.
'Being able to calculate is a part of the skills you should have in mathematics, so you have to train to calculate even with paper and pencil and the head. But this is only one part. The most important thing is to understand what to do and perform what you are supposed to do. There

the computer does not cause any problems. There, I imagine that it can facilitate, because you can do things faster. You can concentrate more on the bits that I did today. So I cannnot see any greater dangers. I fear that the students who has trouble keeping up with the others too easily use the calculator to see that it got right what he did, without really thinking through the task itself. I fear that they will enter 'solve' to see what happens. Then you do not get this struggling like you get when sitting with pencil and paper.'

How did the use of TI-Nspire technology affect the teacher in the teaching practice?
Observations were used to investigate differences across the class before and after using the TI-Nspire technology. During the study, activities on TI-Nspire involved combinations of numeric, graphic, table and writing or other representations. More activities on different concept can be applied by using the instructional activities on TI-Nspire technology. By introducing TI-Nspire technology into teaching approach, it open possibilities to make substantial changes in teaching practice. Teacher's approach in implementing the technology is a crucial part in making changes in the teaching practice.
In the beginning of the study, the researcher was new to using graphing calculator in mathematics teaching. TI-Nspire software emulator were useful in demonstration during lesson, general discussion in class and guiding students in finding keystrokes. Students and teacher were able to work simultaneously by using the software to explore the concept and solve problems. Researcher found that the ways of teaching had changed to some extent where researcher as the teacher act as a facilitator during the study.
Effects of TI-Nspire technology on students' motivation, interest and self-confidence
Students were asked about these effects, both in the interviews and in the questionnaires. One crucial point was the introduction and implementation of the handheld technology.
R: In the beginning, there will be negatives and positives in implementing new technology, because it takes time to adapt with new technological tool. But, once everything has worked smoothly, everyone will grab for it. Indeed, teaching mathematics with technology tool is a very fun class. Students were observed to be responsible of what they are doing because in graphing calculator, one cannot copy from other students.
With the final exercises in this study, students' general skills in using the handheld units were put to a test. The observation of the classes showed that they handled TI-Nspire in a satisfying way, but there were time when they wasted more on finding the keystrokes and choosing functions on the graphing calculator.
As expected, most students think that it is more fun with mathematics with TI-Nspire, because mathematics appears in a new way, it gives you more power and it is appealing to work with. This affects their beliefs about mathematics and mathematical activities, and the also believe that TI-Nspire has a positive effect on their mathematical knowledge and ability. The usefulness of technology in the future was also commented by students and researchers:
R: Technology develop rapidly in this world, mathematics shouldn't be taught in traditional way as it doesn't apply to new generation. It's because the mind of children develop consistent with surrounding modern technological environment. Thus, why not TI-Nspire be introduced to students now?

Conclusion

The teaching strategy using TI-Nspire technology was implemented as an instructional tool to teach three concepts in Calculus that are limit and continuity, differentiation and integration. Students' and teacher (researcher) experience in using the technology was determined from the questionnaires, interview and observation.

Students expressed common advantages with the TI-Nspire technology in general. Among these were more physical features, in example a clear, colorful screen and flexible to work with. But more important are the mathematical features in the graphing calculator, e.g. easier to work with functions and other areas of mathematics, new ways to work with problem-solving, managing more difficult tasks. They like learning mathematics with TI-Nspire, understanding concept better and possibilities to focus on doing mathematics.

Researcher stated that the ways of teaching had changed to some extent. The general changes were in using the TI-Nspire software emulator and display it on a screen in teaching calculus. Instructional that focusing more on to concept exploration and problem-solving allow group discussion to occur in the class. The graphing tool act as a calculator, a problem-solving tool, and to discover mathematical concepts well. Among common obstacles to high-quality teaching were that students could have difficulties in handling the technology. Students discuss more with others and becoming active participants during the study.

Based on the finding, graphing calculator TI-Nspire reinforces students' understanding on mathematical concept as well as stimulates students to think mathematically by discovering and exploring the concepts through TI-Nspire instructional activities. TI-Nspire handheld offers a number of applications on Calculus which visualize the concept of Calculus. With the use of instructional activities, students can learn Mathematics by discovery. Besides, teachers who have time restriction to design instructional activities, there are abundance of documents available on the Texas Instrument (TI) websites which is an advantage for teachers and students too. Switching on to TI-Nspire technology for a mathematics classroom is highly recommended to make learning mathematics more fun and meaningful.

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